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Mineral Development in Ontario North of 50°

Technical Paper # 13

Sensitivity of I.R.R. to Price Changes and
Determination of Economic Threshold and
Desired I.R.R.

Prof. O. T. Djamgouz

the ROYAL COMMISSION on the
NORTHERN ENVIRONMENT



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**Sensitivity of I.R.R. to Price Changes
and Determination of Economic Threshold and
Desired I.R.R.**

Prof. O.T. Djamgouz

School of Engineering
LAURENTIAN UNIVERSITY

1981

This technical report provides background material for the final report Mineral Development in Ontario North of 50°, submitted to the Royal Commission on the Northern Environment by Laurentian University in September, 1982.

However, no opinions, positions or recommendations expressed herein should be attributed to the Commission; they are solely those of the authors.

SENSITIVITY OF I.R.R. TO PRICE CHANGES

The sensitivity analysis has been conducted for each metal existing in blocks I to X north of 50th parallel, by varying the 1979 prices. The economic threshold is accepted to be 15 per cent I.R.R. and the desired I.R.R. is accepted at 25 per cent. The graphical analyses are illustrated in Figs. 1 to 23.

COPPER:

According to our studies the copper deposits in blocks 1, 3, 5, and 10 are not profitable when mined with underground mining methods. However, the optimum production rate for open pit mining in block #1 is 4000 tons per day and the I.R.R. is little over 30 per cent for 1979 copper price of 92.33¢ per lb. In block #3 if the 1979 copper price is increased by 11% to 102.5¢ per lb. the economic threshold of 15% would be reached. In order to get the desired 25% I.R.R. the 1979 copper price has to increase by 40%. In block #5 the 1979 copper price has to be increased by 28% and reached to 118.2¢ per lb. in order to have 15% I.R.R. and increased by 72% to have 25% I.R.R. The copper deposits in block 10 are economical at present prices and I.R.R. is little over 30%.

COPPER-ZINC:

OPEN PIT PRODUCTION:

The optimum production rate is 8000 tons per day and the I.R.R. of all of the copper-zinc deposits in blocks 1, 3, 4, 5 and 6 are in excess of economic threshold of 15%. The Cu-Zn

deposits in block #2 are not economical and in order to reach the economic threshold of 15% I.R.R. the Cu-Zn prices has to be 73% higher than the 1979 prices. With the exception of deposits in blocks 1, 2, and 3 all of the Cu-Zn deposits are economical to mine and I.R.R. is in excess of desired 25%. The I.R.R. of deposits in blocks 1 and 3 could reach to desired 25% if the 1979 prices are increased by 3 and 37% respectively.

CUT & FILL PRODUCTION:

The optimum production rate is 8000 tons per day and all of the copper-zinc deposits in blocks 1, 2, 3, 4 and 6 are not economical to mine. However, if the 1979 copper-zinc prices would increase by 54%, 46% and 33% the deposits in blocks 1, 2, 4 and 6 respectively, would bring I.R.R. of 15% which is economic threshold. However, deposits in block 3 are not economical.

COPPER - LEAD - ZINC (Cu-Pb-Zn) (Base Metals):

OPEN PIT PRODUCTION:

With the 8000 tons per day production rate all deposits in blocks from 1 to 10 are economically viable and could bring in at least 25% I.R.R.

CUT & FILL:

With the exception of deposits in blocks 1 and 7 all deposits could earn the I.R.R. of 15% which is the economic threshold. The deposits in blocks #1 and 7 could earn the I.R.R. of 15% if the metal prices of 1979 could be increased by 67 and 13 per cent respectively.

The earnings of deposits in 4, 5, 8, 9 and 10 are all at

or above the desired level of I.R.R. 25%. With the exception of deposits in 1 and 3 the deposits in blocks 2, 6 and 7 could earn the desired I.R.R. of 25% if the 1979 prices would increase by 10, 32 and 58% respectively.

LEAD-ZINC:

OPEN PIT PRODUCTION:

With the exception of deposits in block - 10 all the deposits in 2, 3, 4 and 5 are earning I.R.R. above the economic threshold 15%. Deposits in block #10 could become economic if the 1979 metal prices are increased by 78%. With the exception of deposits in blocks 5 and 10 others could earn above the desired 25% I.R.R. Deposits in block #5 could earn 25% I.R.R. if the 1979 prices would be increased by 33%.

CUT & FILL PRODUCTION:

Deposits in blocks 3 and 4 could earn above the economic threshold 15% and deposits in blocks 2 and 5 could have the I.R.R. of 15% if the 1979 prices are increased by 48 and 49% respectively.

If the 1979 prices are increased by 83, 62, 21 and 90% the deposits in 2, 3, 4 and 5 could earn the desired I.R.R. of 25% respectively.

NICKEL-COPPER:

OPEN PIT PRODUCTION:

All deposits in blocks 1, 3, 6 and 7 have I.R.R. above 25% and in block #2 the I.R.R. could reach to 25% if the 1979 metal prices are increased by 10%.

CUT & FILL PRODUCTION:

All deposits in blocks 2, 3, 6 and 7 have I.R.R. below economic threshold 15% but could reach to it if the 1979 prices are increased by 30, 50, 25 and 20% respectively. If the metal prices would increase by 75, 90, 48 and 68% the earnings could reach to 25% I.R.R. in blocks 2, 3, 6 and 7 respectively.

MOLYBDENUM:OPEN PIT PRODUCTION:

All deposits in blocks 1 and 6 have I.R.R. above the 25%.

CUT & FILL PRODUCTION:

All deposits in blocks 1 and 6 have I.R.R. below the economic threshold 15%. However, if the 1979 metal prices would increase by 10 and 28% the I.R.R. in block #1 would increase to 15 and 25% respectively and if the 1979 metal prices would increase by 19 and 41% the I.R.R. in block #6 would increase to 15 and 25% respectively.

URANIUM:OPEN PIT PRODUCTION:

All deposits in blocks 1, 2, 3, 5, 6, 7, 9 and 10 have I.R.R. above the desired 25%

CUT & FILL PRODUCTION:

With the exception of block #1 all of the deposits in blocks 2, 3, 5, 6, 7, 9 and 10 have I.R.R. above the economic threshold 15% and deposits in block #1 could have I.R.R. 15% if the metal prices is increased by 90%. The deposits in blocks

2, 3 and 6 have I.R.R. above 25% and those in 5, 7, 9 and 10 could have I.R.R. equal to 25 if the uranium prices are increased by 11, 45, 9 and 10% respectively.

GOLD:

OPEN PIT PRODUCTION:

All deposits in blocks 1, 2, 3, 5, 6, 7, 8 and 9 have I.R.R. equal or higher than 25%.

CUT & FILL PRODUCTION:

All ore deposits in blocks 3 and 5 have I.R.R. equal or higher than the economic threshold 15% and deposits in blocks 1, 2, 6, 7, and 9 could have I.R.R. equal to 15% if the 1979 gold prices are increased by 40, 35, 20, 8 and 36% respectively. In order to have I.R.R. at 25% for the ore deposits in blocks 1, 2, 3, 5, 6, 7 and 9 the 1979 gold price should be increased by 83, 79, 19, 25, 43, 30 and 65% respectively.

SILVER:

OPEN PIT PRODUCTION:

All ore deposits in blocks 3, 5 and 9 have I.R.R. higher than 15% and deposits in 1, 2 and 6 could have I.R.R. 15% if the 1979 silver prices would be increased by 65, 100 and 4% respectively. The deposits in blocks 1, 3, 5, 6 and 9 could have I.R.R. 25% if the 1979 silver prices would be increased by 64, 5, 10, 15, 6% respectively.

IRON:OPEN PIT PRODUCTION:

Deposits in blocks 1, 2, 3, and 6 have I.R.R. less than 15% and if the 1979 prices would be increased by 85, 85, 29 and 45% respectively the economic threshold 15% would be reached. However, only deposits in block 3 could have I.R.R. of 25% if the 1979 iron price would be increased by 77%.

LITHIUM OR COLOMBIUM:OPEN PIT AND CUT & FILL:

(In both cases), the Li or Cb deposits, have I.R.R. higher than 25%.

CHROMIUM:OPEN PIT PRODUCTION:

Deposits in blocks 1 and 7 have I.R.R. above the 25%.

CUT & FILL PRODUCTION:

Deposits in blocks #7 have I.R.R. higher than 25% and in block #1 would have I.R.R. equal to 25% if the 1979 price increased 27%.

COBALT:

For both mining methods (open pit and cut & fill) the I.R.R. is much higher than 25%.

PLATINUM:OPEN PIT PRODUCTION:

The deposits in block #7 have I.R.R. higher than 15%

and I.R.R. would reach to 25 if the 1979 price is increased by 12%.

CUT & FILL PRODUCTION:

The deposit in block #7 could have I.R.R. of 15% if the 1979 price is increased by 68%.

SENSITIVITY OF I.R.R. TO PRICE CHANGES
COPPER PRODUCTION FOR BLOCKS 1 TO 10
MINING METHOD: OPEN PIT.

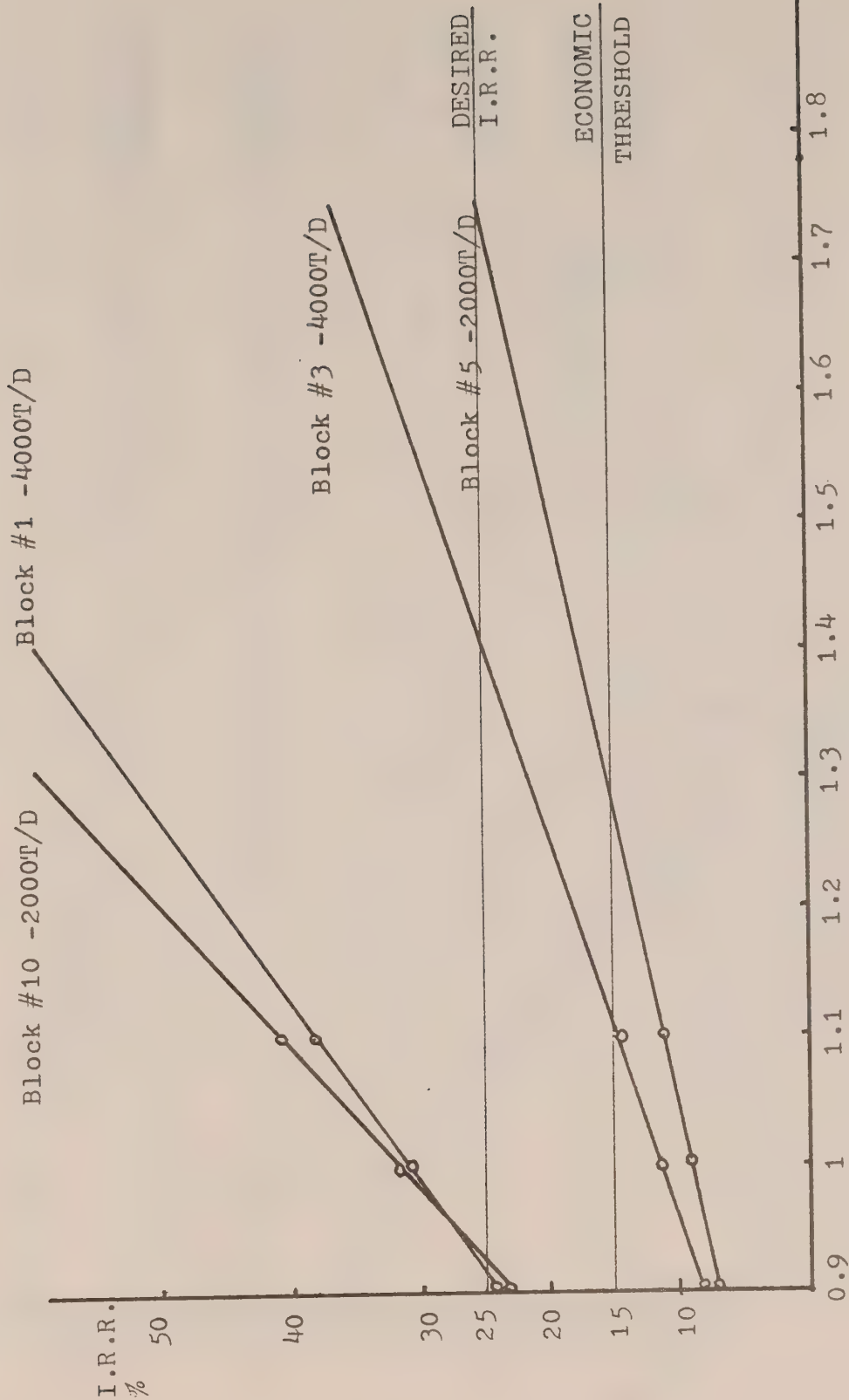


Fig. 1
PRICE FACTOR
1 REPRESENTS THE PRICE OF COPPER AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 Cu Zn PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT
 ALL BLOCKS AT 8000T/D

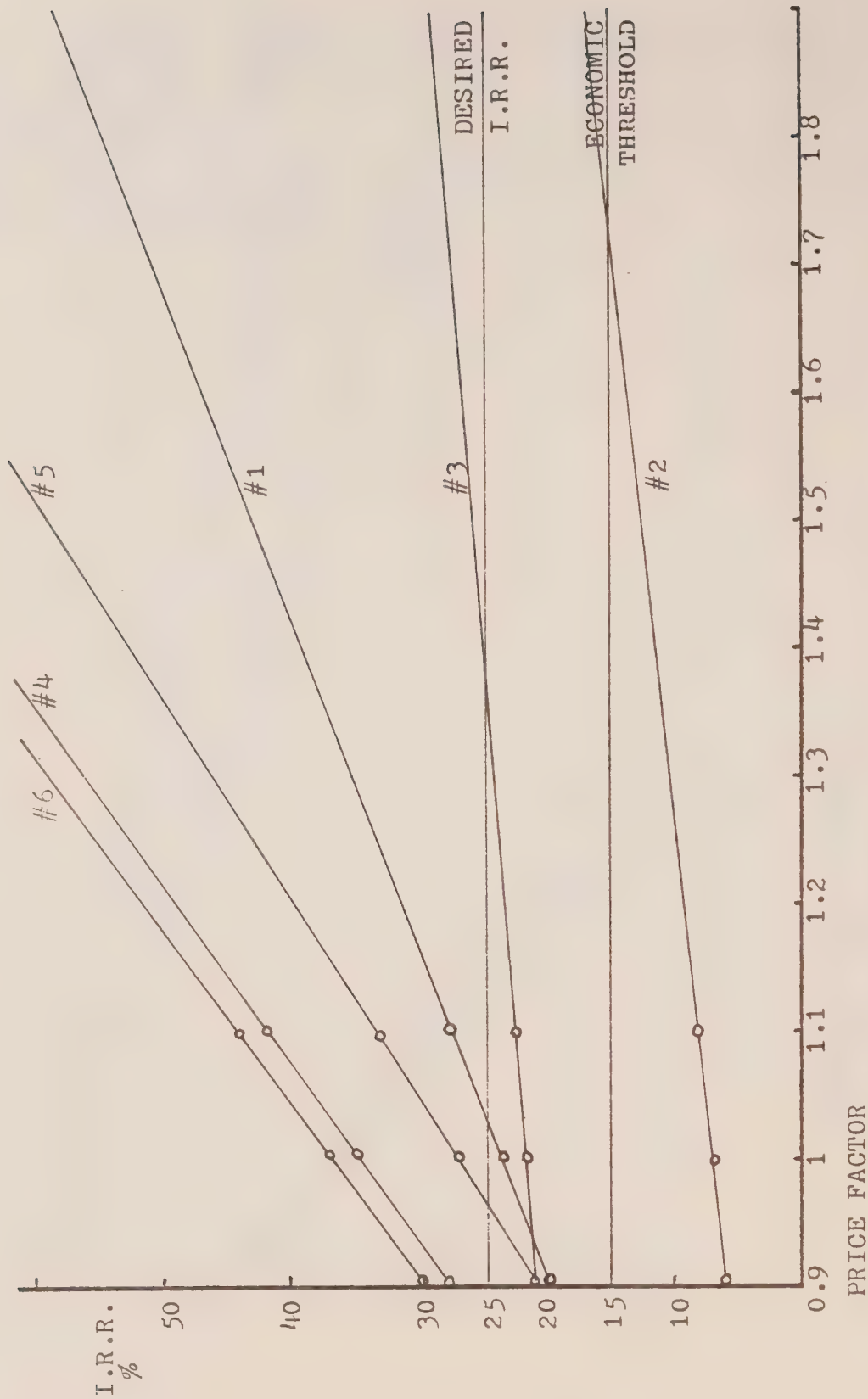


Fig. 2 1 REPRESENTS THE PRICE OF COPPER-ZINC AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 Cu Zn PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

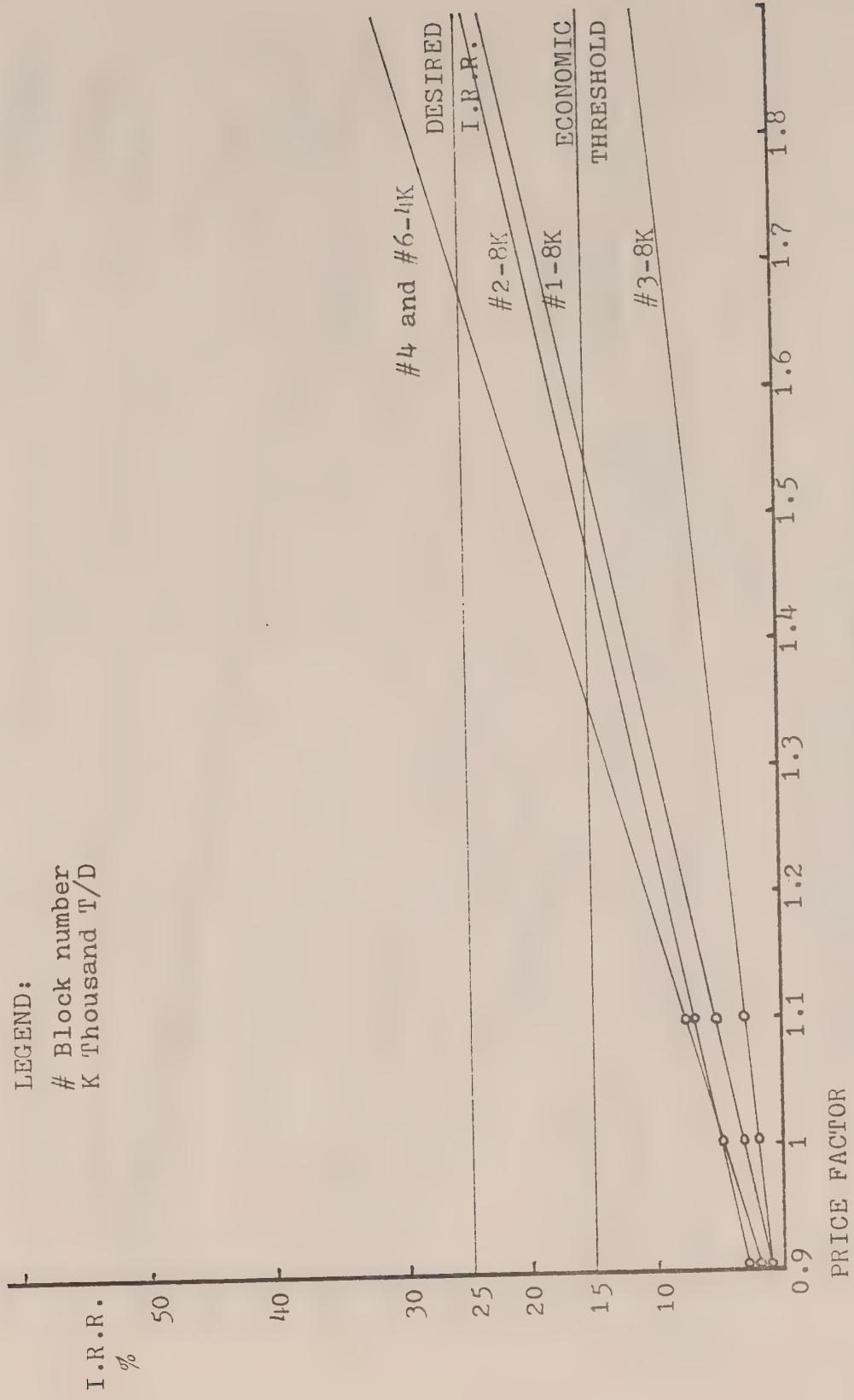
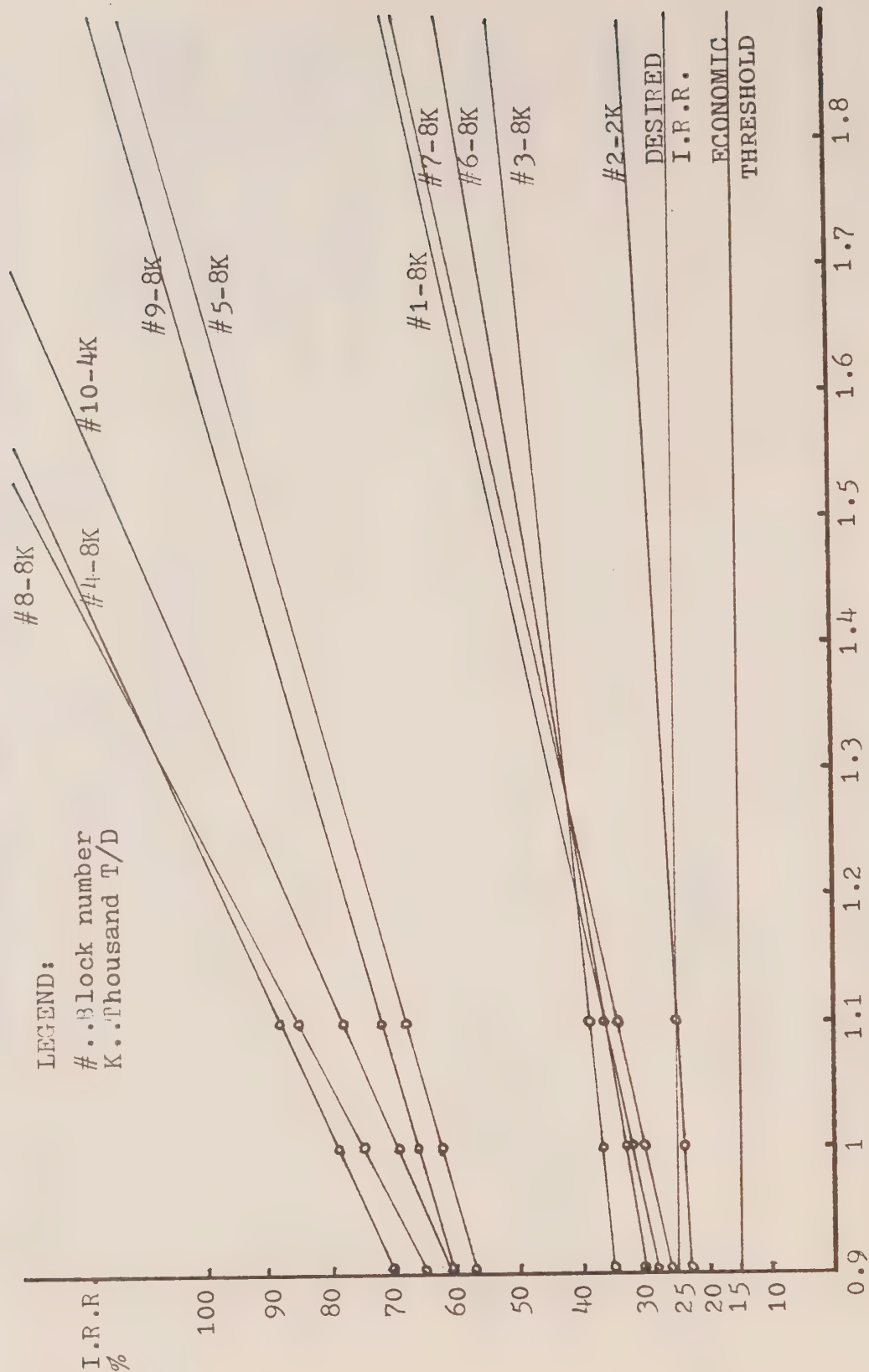


Fig. 3 1 REPRESENTS THE PRICE OF COPPER-ZINC AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 Cu Pb Zn PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT



PRICE FACTOR

1 REPRESENTS THE PRICE OF Cu Pb Zn AT 1979 CONSTANT DOLLARS

Fig. 4

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 Cu Pb Zn PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

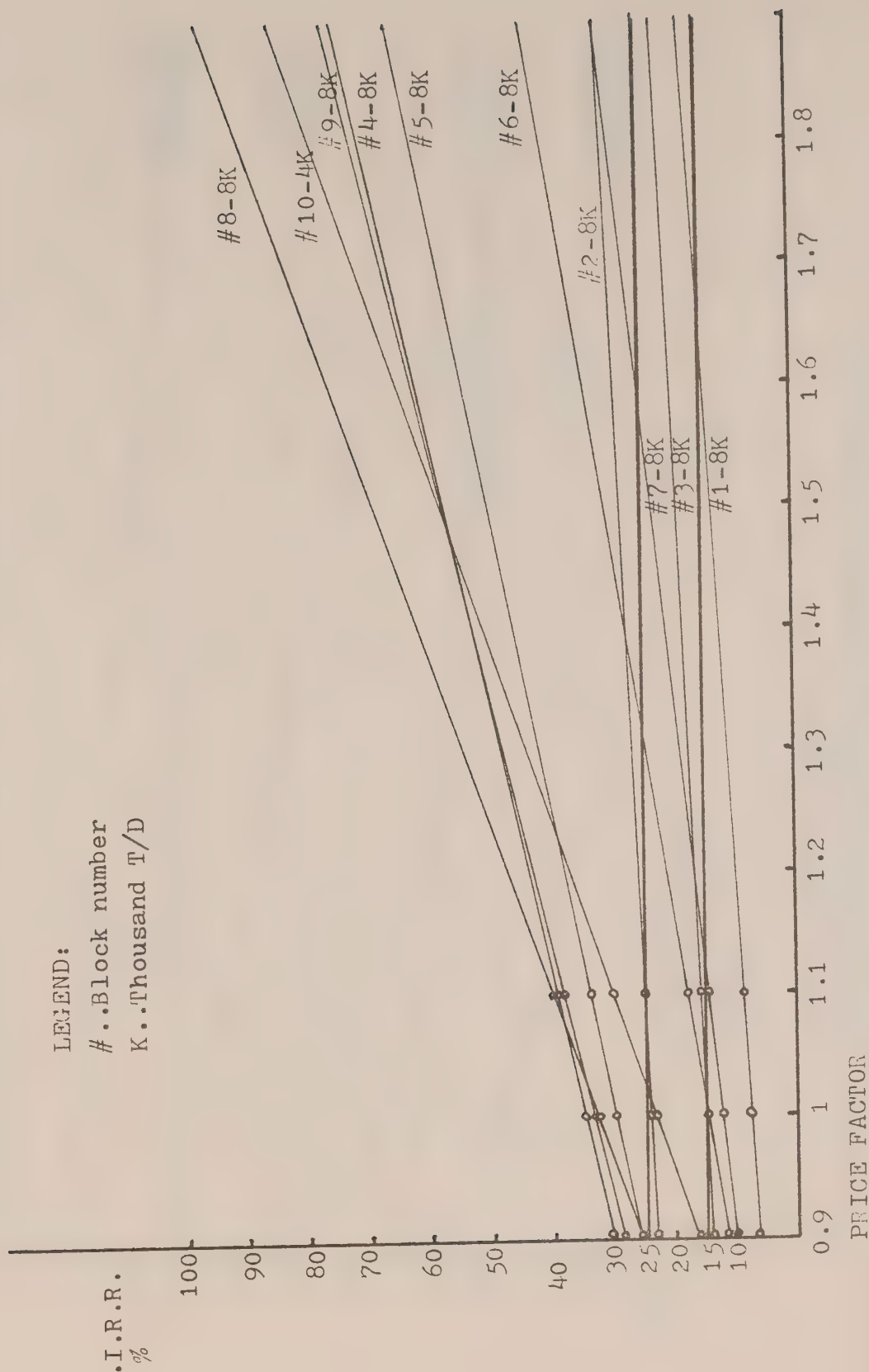


Fig. 5 1 REPRESENTS THE PRICE OF Cu Pb Zn AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
LEAD-ZINC PRODUCTION FOR BLOCKS 1 to 10
MINING METHOD: OPEN PIT

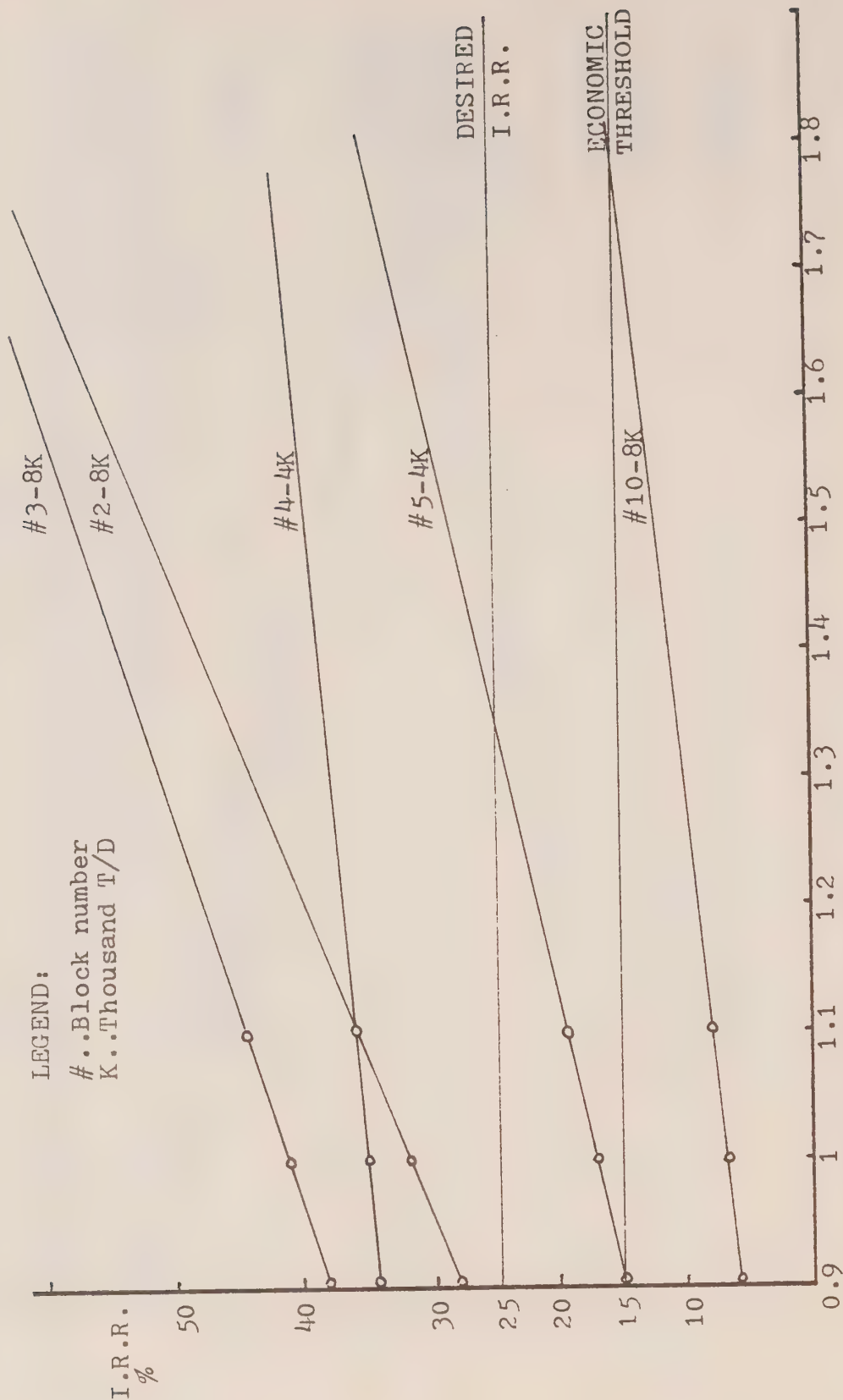


Fig. 6 1 REPRESENTS THE PRICE OF LEAD-ZINC AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
LEAD-ZINC PRODUCTION FOR BLOCKS 1 to 10
MINING METHOD: CUT AND FILL

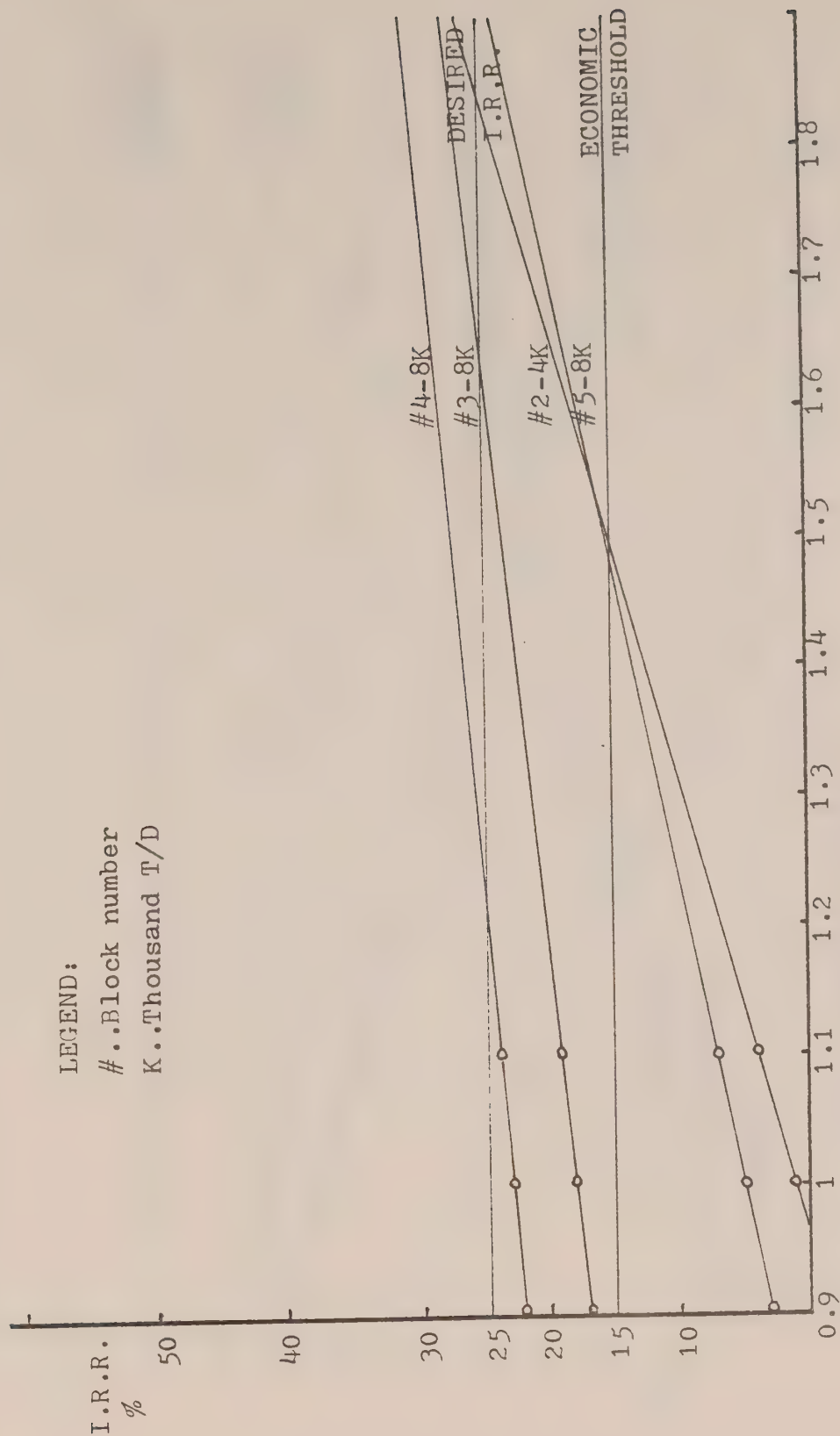


Fig. 7 1 REPRESENTS THE PRICE OF LEAD-ZINC AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 NICKEL-COPPER PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT

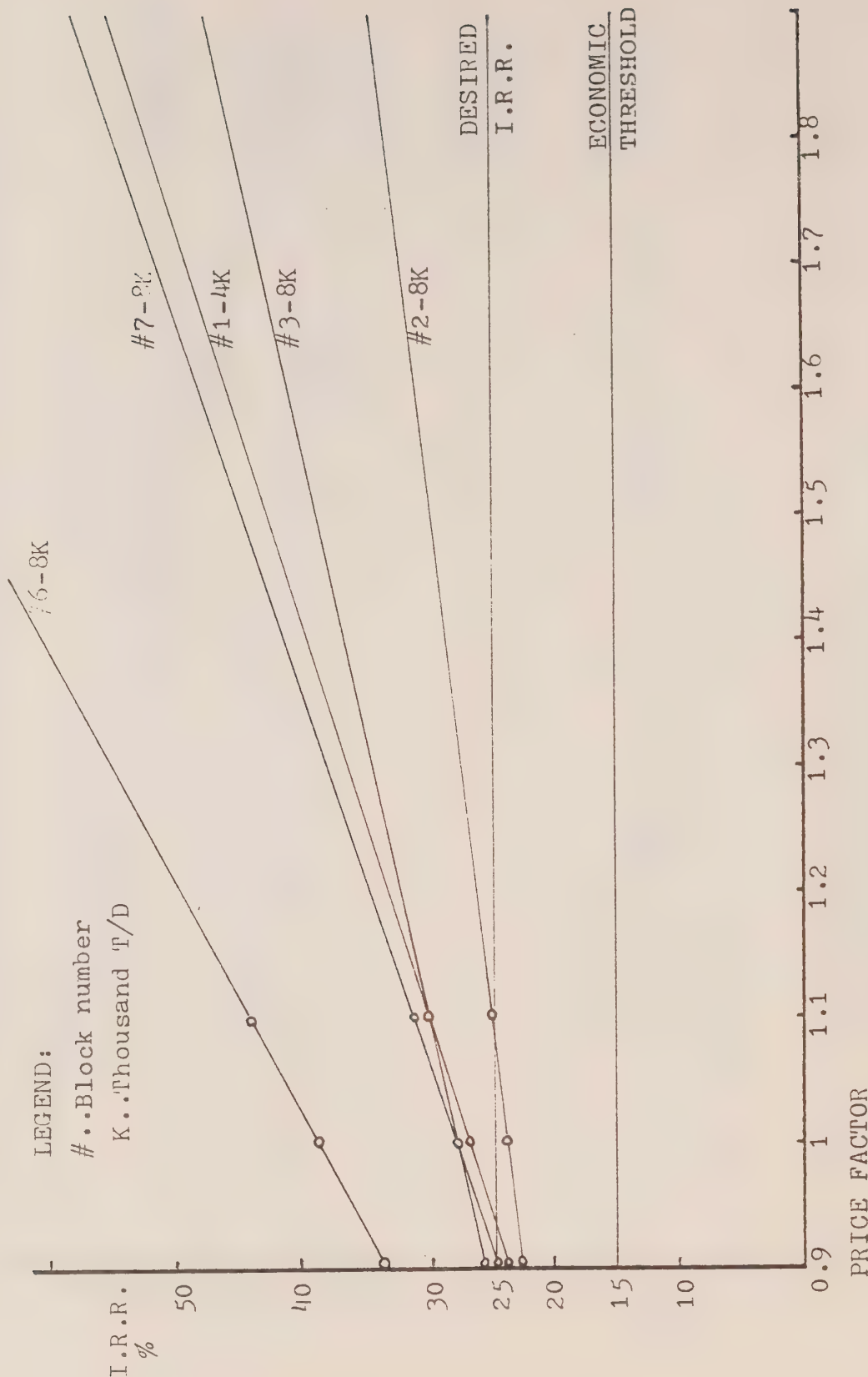


Fig. 8 1 REPRESENTS THE PRICE OF NICKEL-COPPER AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 NICKEL-COPPER PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

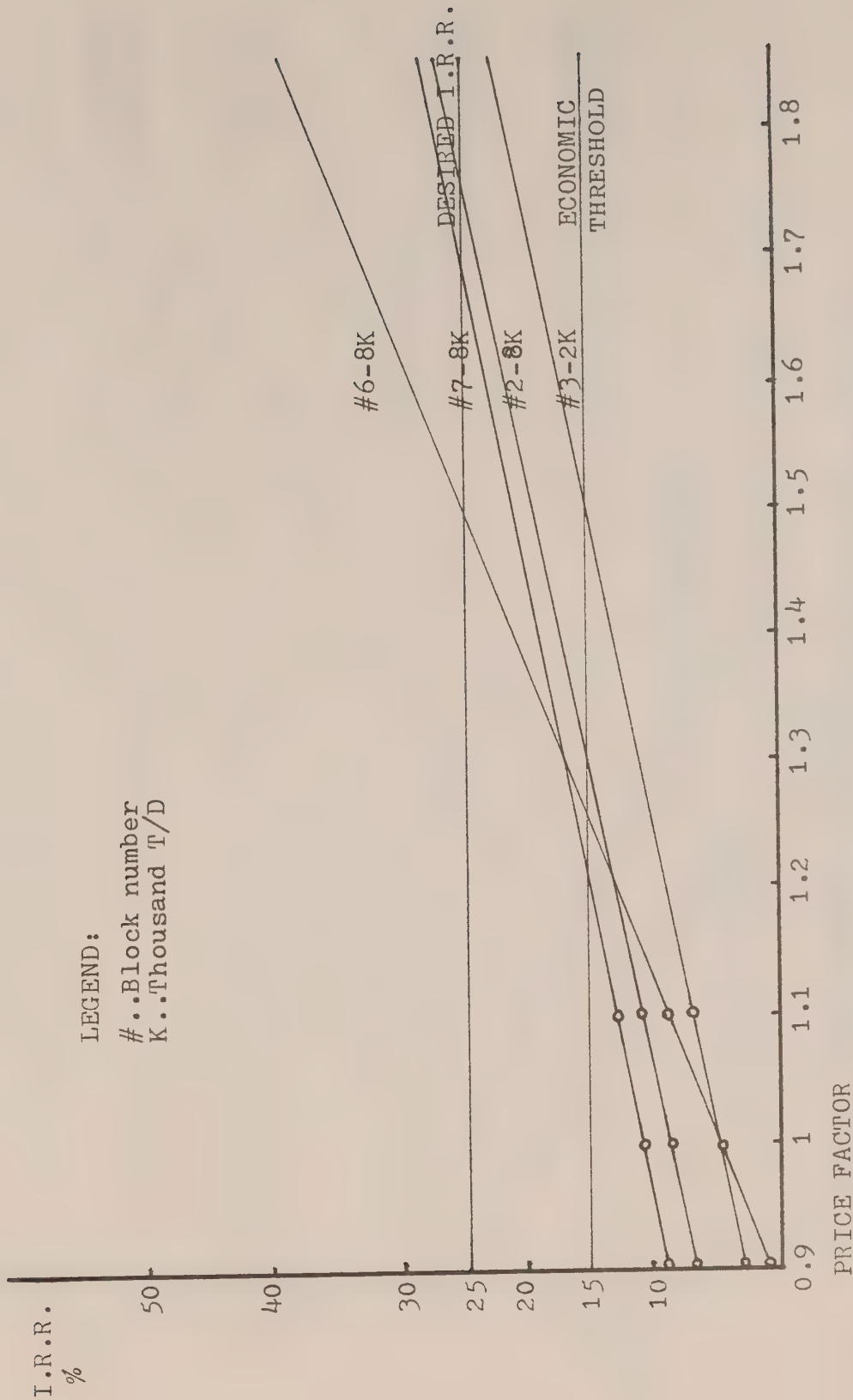
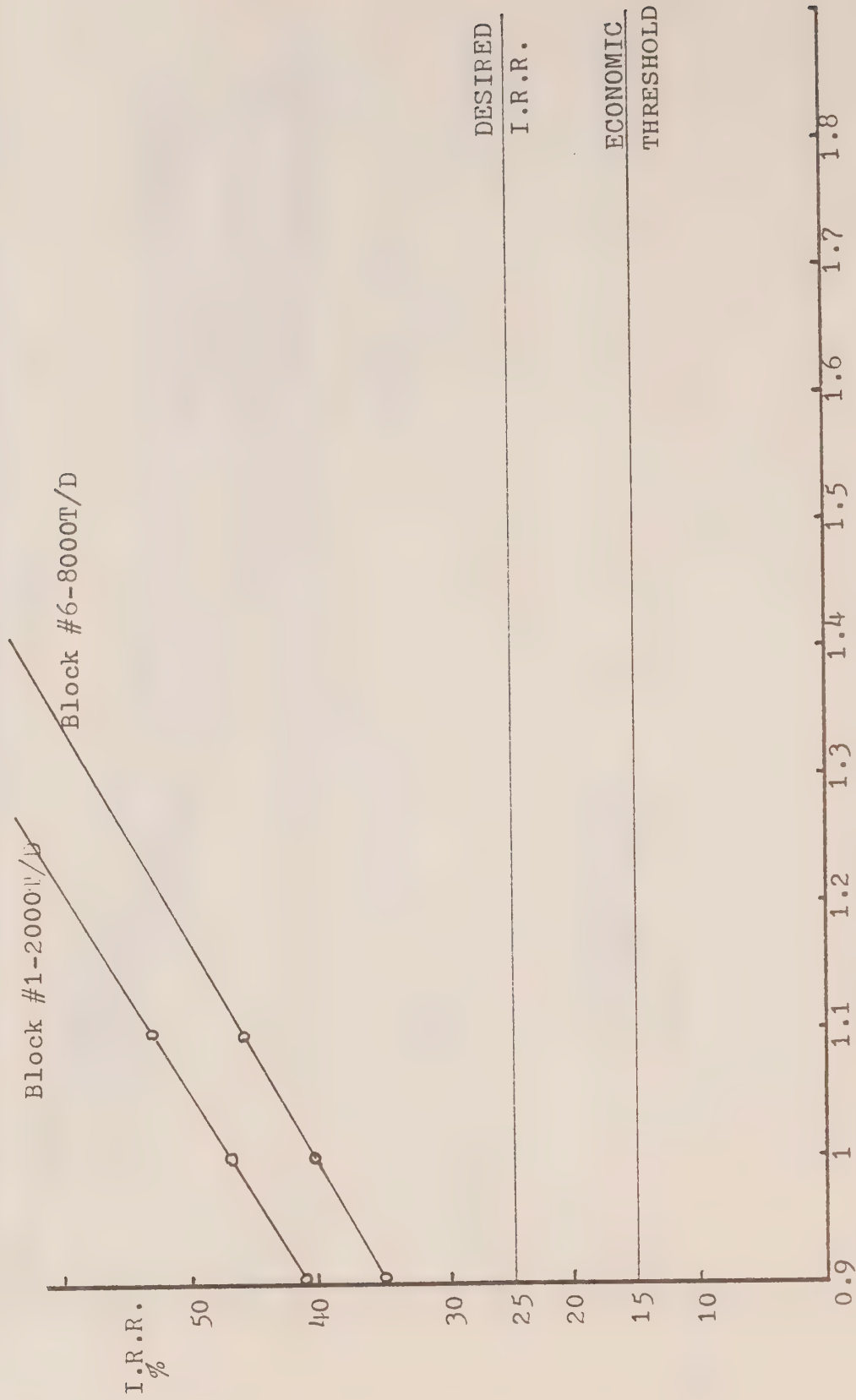


Fig. 9 1 REPRESENTS THE PRICE OF NICKEL-COPPER AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 MOLYBDENUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT



1 REPRESENTS THE PRICE OF MOLYBDENUM AT 1979 CONSTANT DOLLARS

Fig. 10

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 MOLYBDENUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

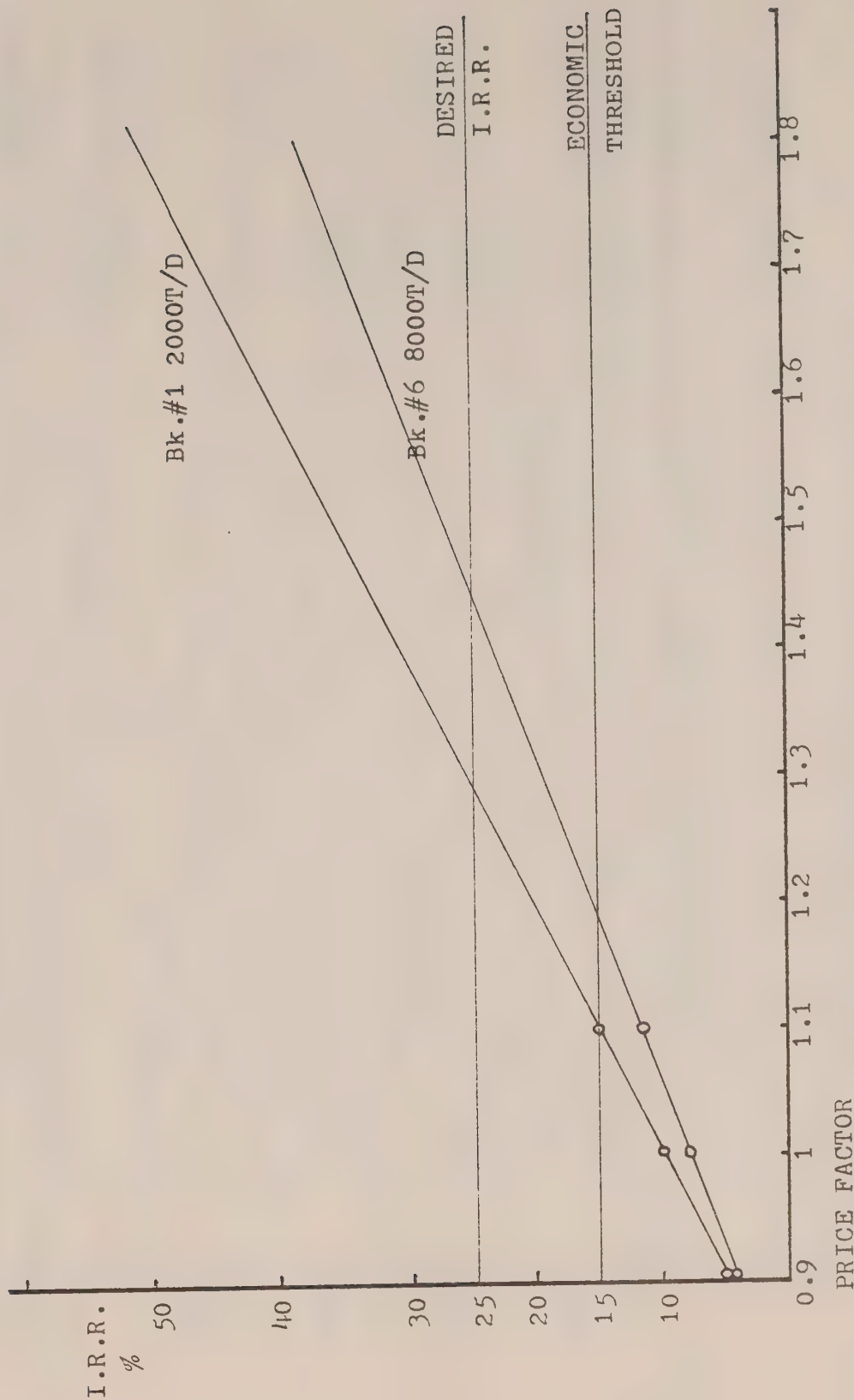


Fig. 11 1 REPRESENTS THE PRICE OF MOLYBDENUM AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 URANIUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT

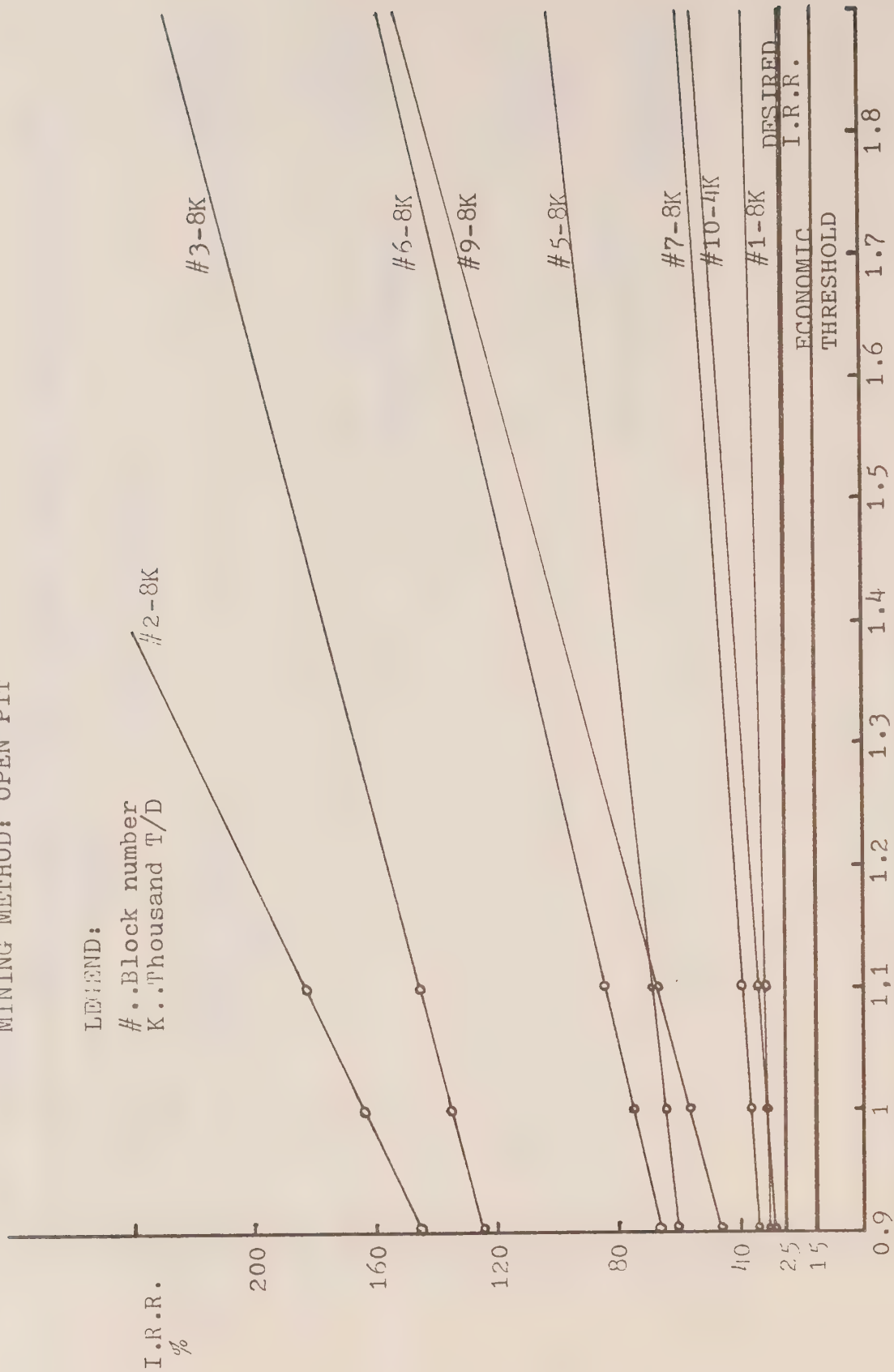


Fig. 12 1 REPRESENTS THE PRICE OF URANIUM AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 URANIUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

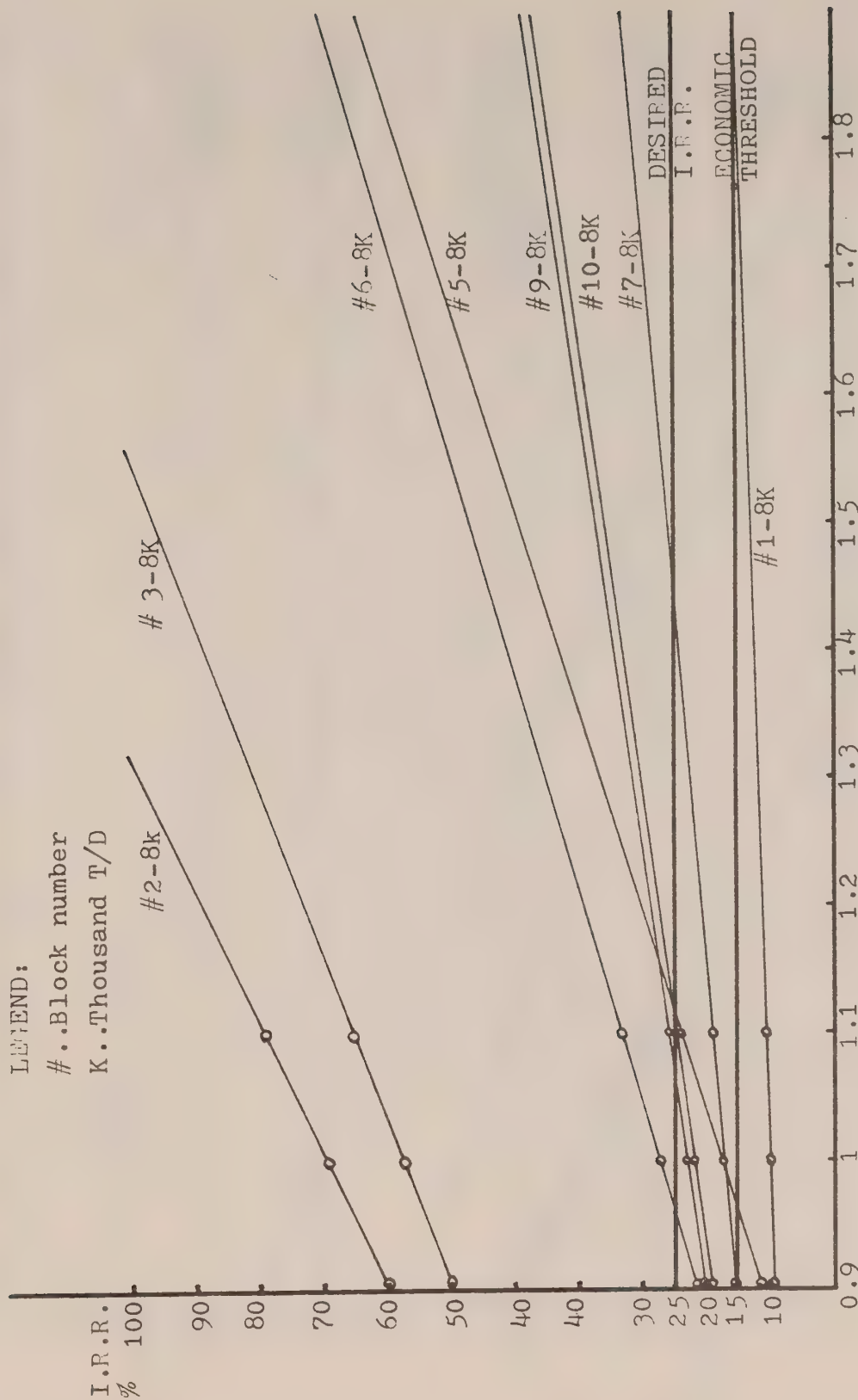


Fig. 13 1 REPRESENTS THE PRICE OF URANIUM AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 GOLD PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT.

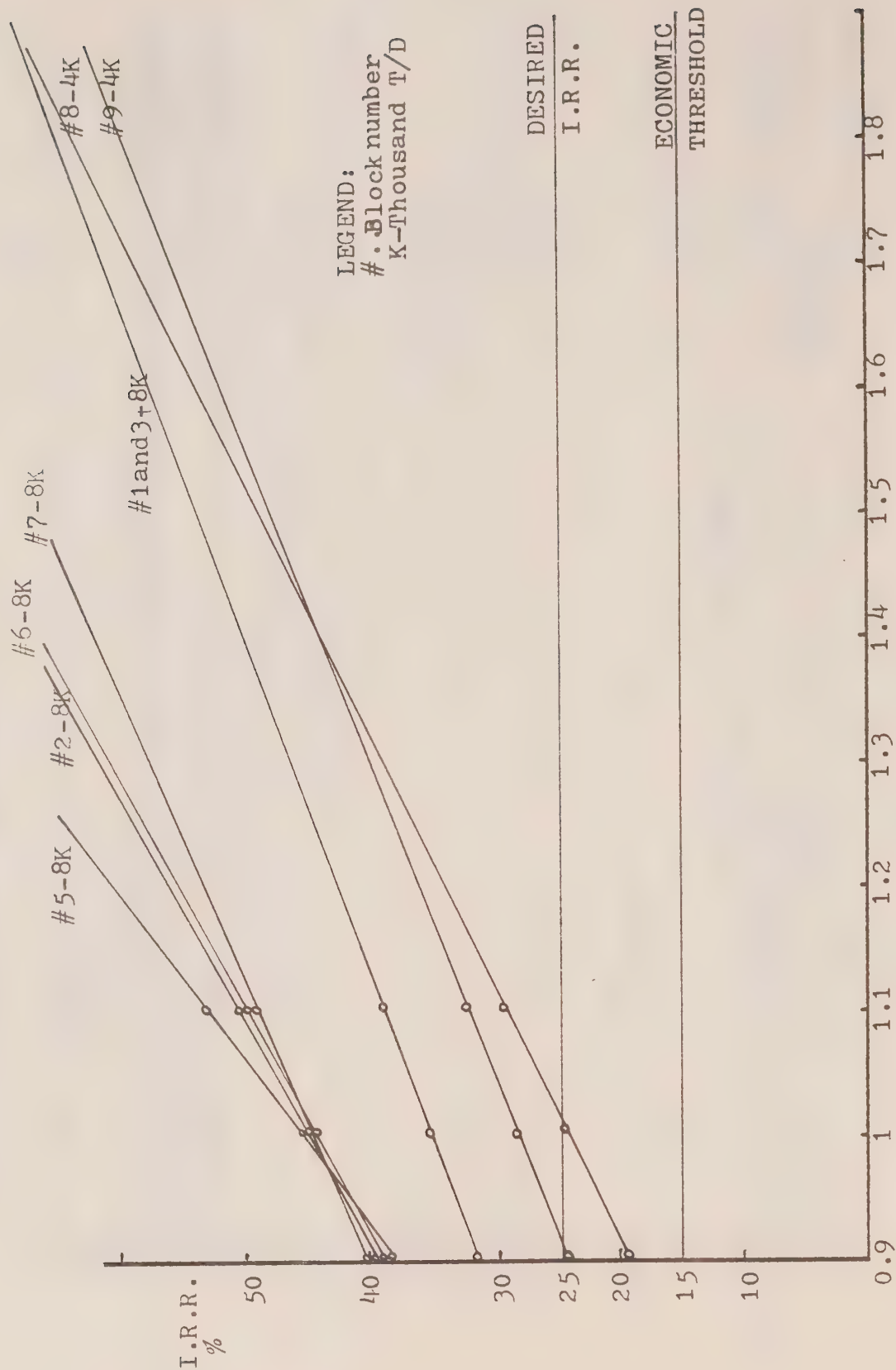


Fig. 14 PRICE FACTOR
 1 REPRESENTS THE PRICE OF GOLD AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 GOLD PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

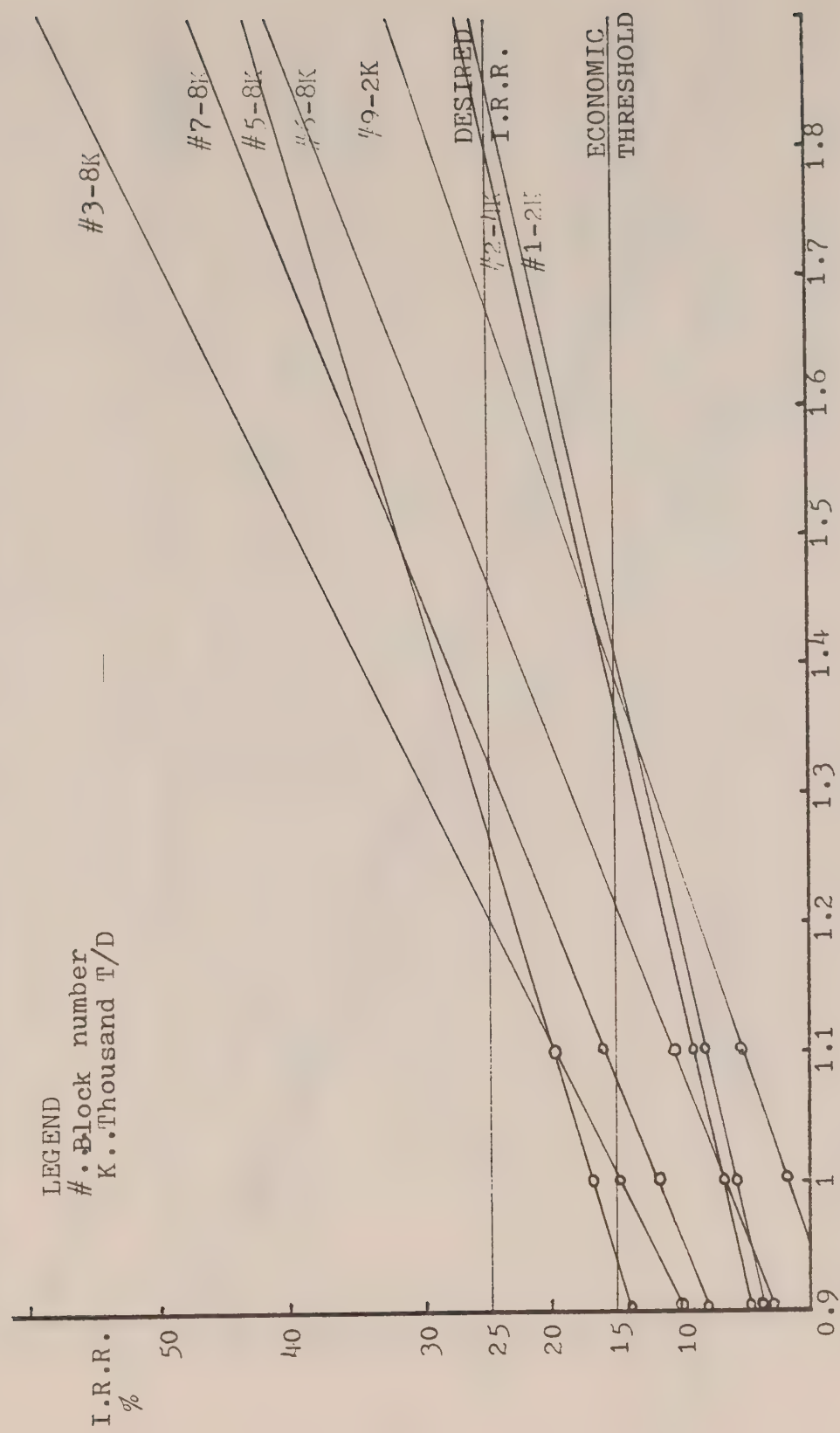


Fig. 15 1 REPRESENTS THE PRICE OF GOLD AT 1979 CONSTANT DOLLARS

SENSITIVITY OF PRICE CHANGES TO I.R.R.
 SILVER PRODUCTION FOR BLOCKS 1 TO 10
 MINING METHOD: OPEN PIT

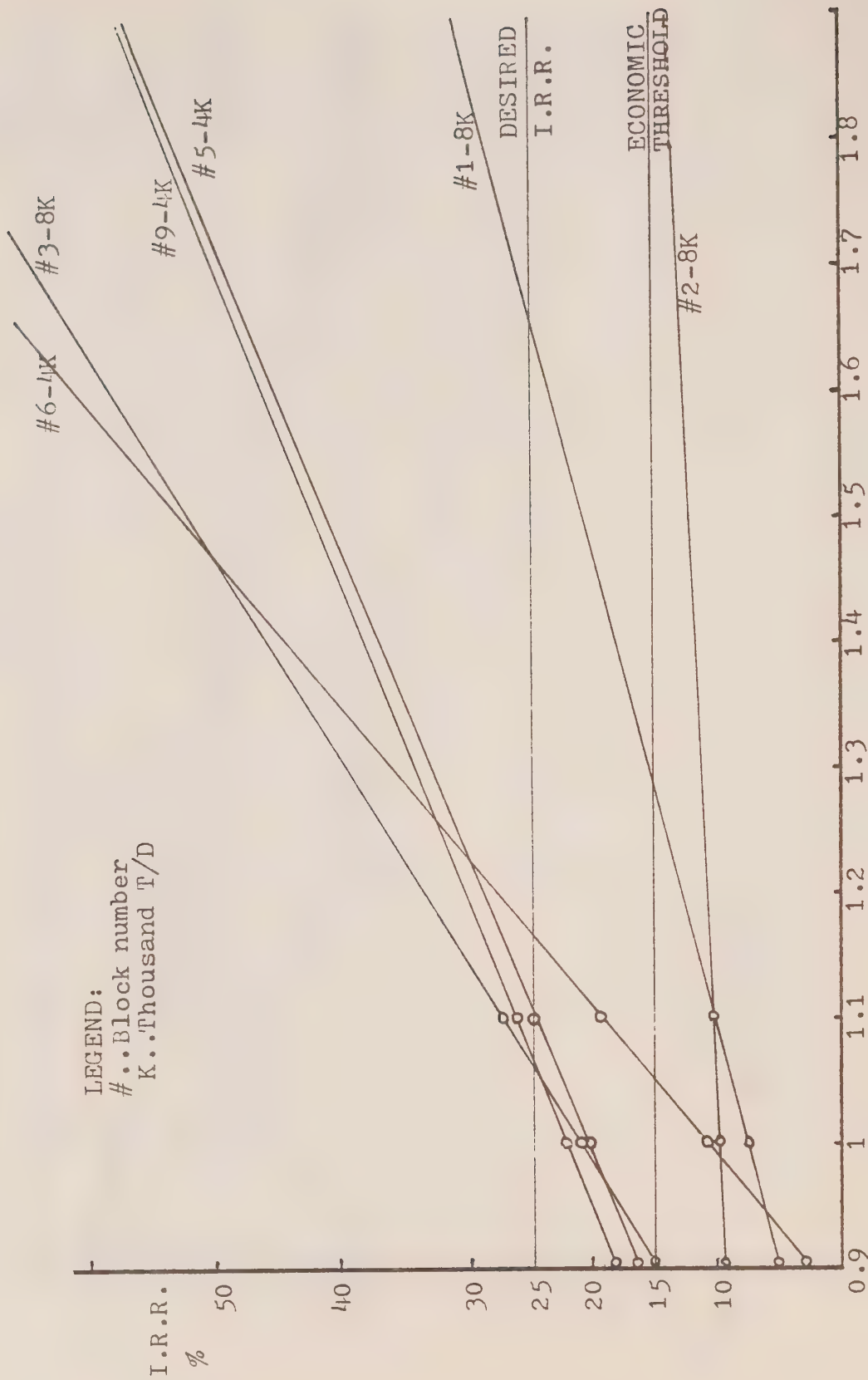


Fig. 16 1 REPRESENTS THE PRICE OF SILVER AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 IRON PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT.

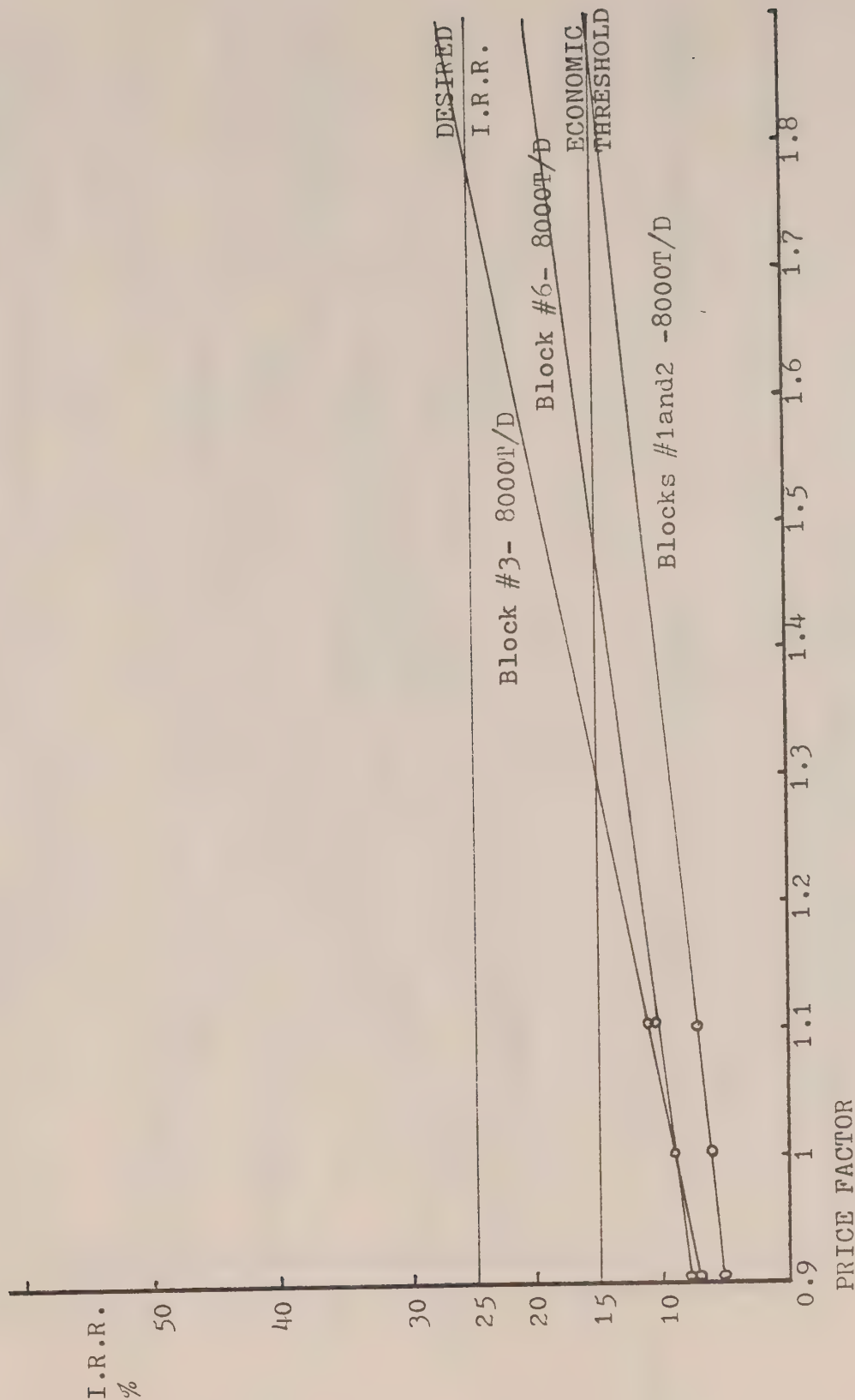
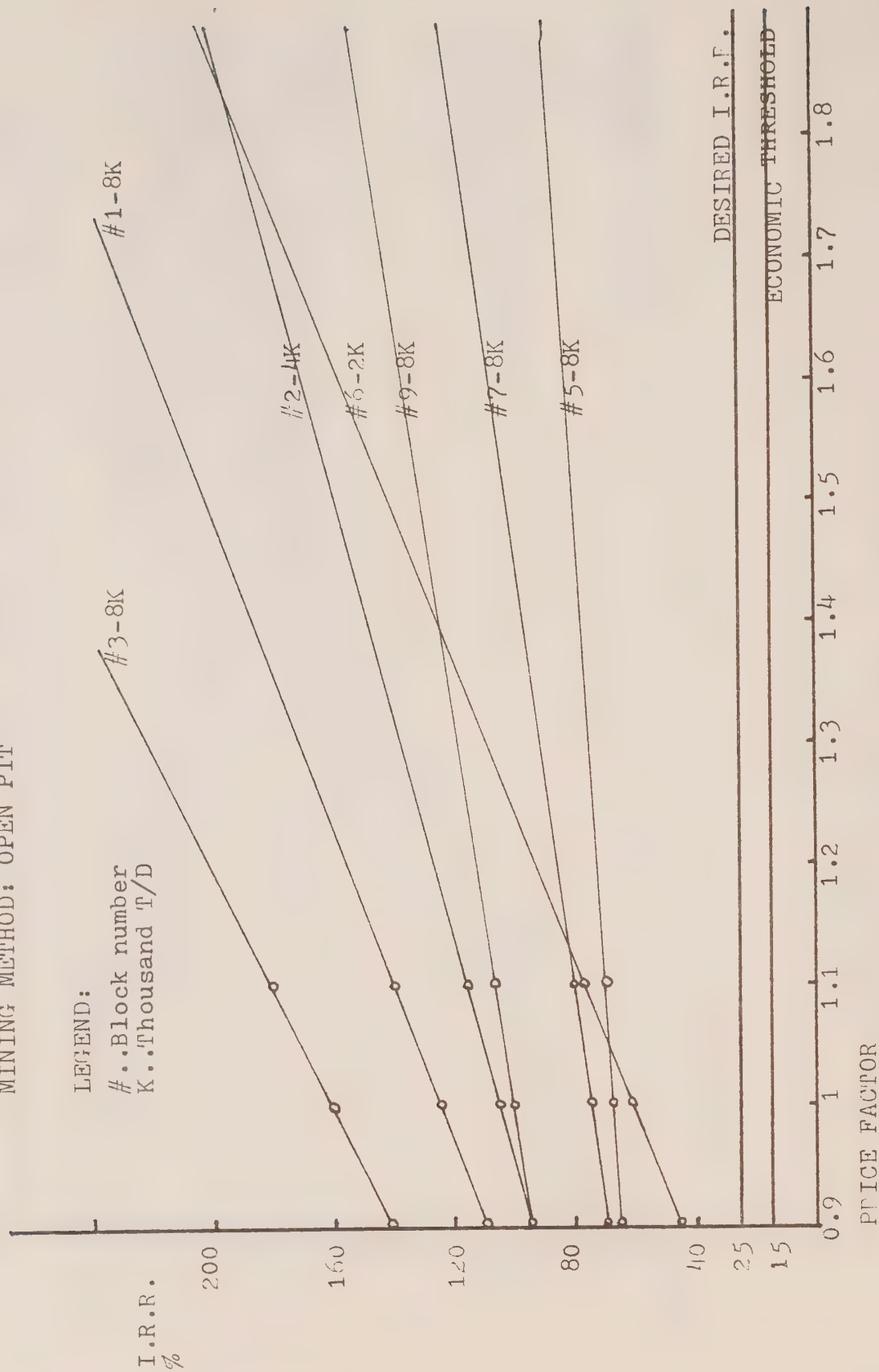


Fig. 17 1 REPRESENTS THE PRICE OF IRON AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
Li Cb PRODUCTION FOR BLOCKS 1 to 10
MINING METHOD: OPEN PIT



1 REPRESENTS THE PRICE OF Li Cb AT 1979 CONSTANT DOLLARS

Fig. 18

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 Li Cb PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

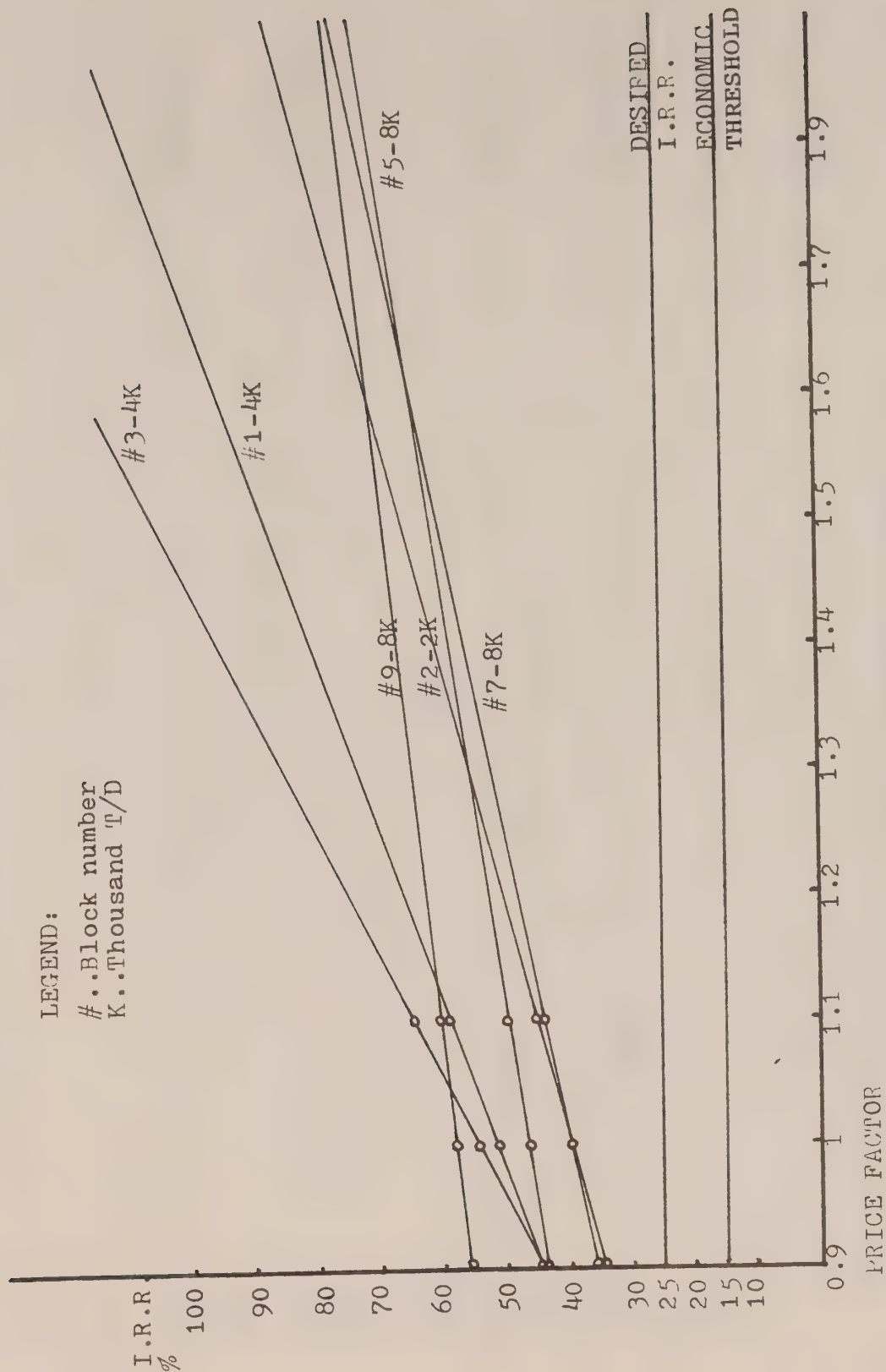


Fig. 19 1 REPRESENTS THE PRICE OF Li Cb AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 CHROMIUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: OPEN PIT

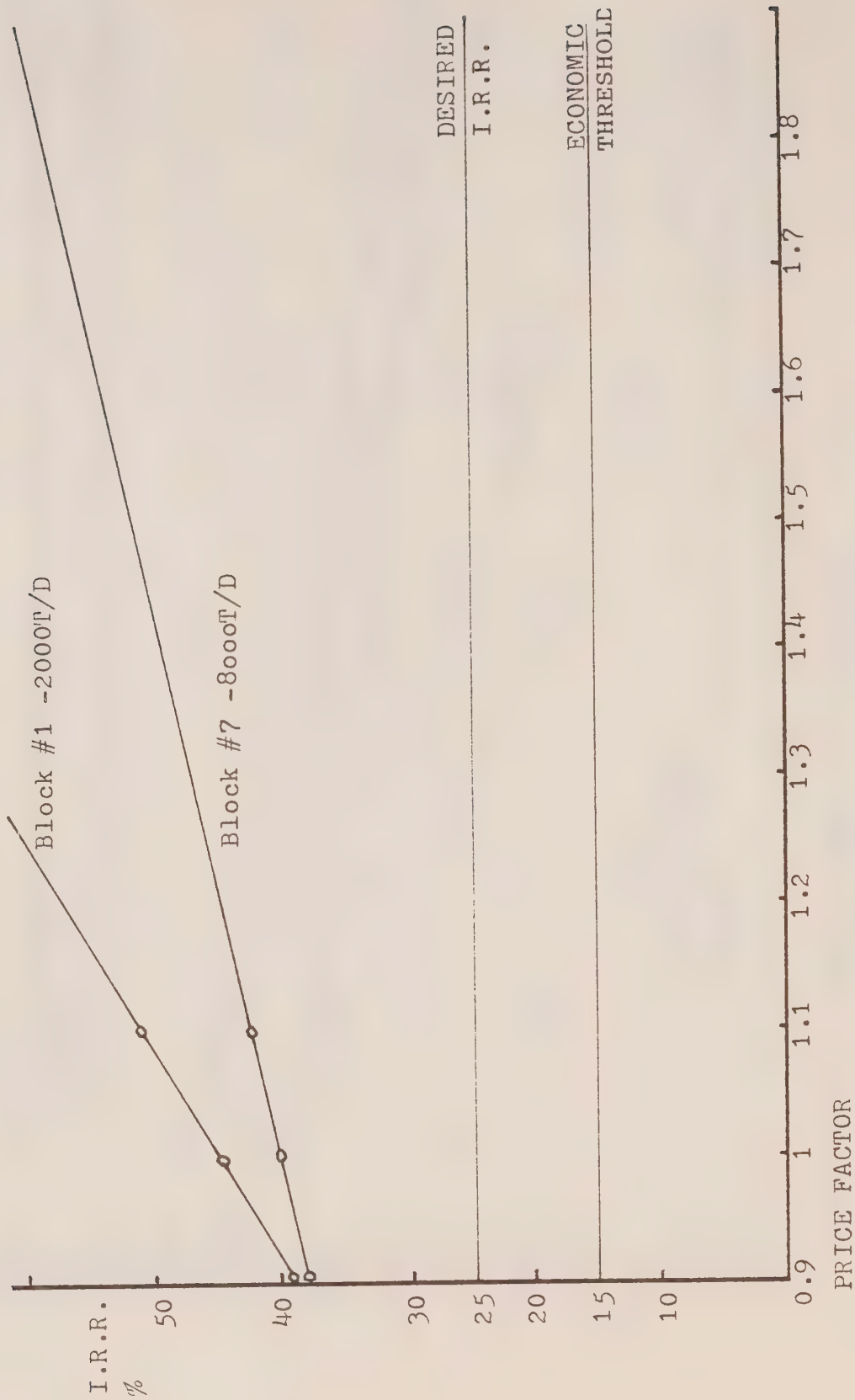


Fig. 20 1 REPRESENTS THE PRICE OF CHROMIUM AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
 CHROMIUM PRODUCTION FOR BLOCKS 1 to 10
 MINING METHOD: CUT AND FILL

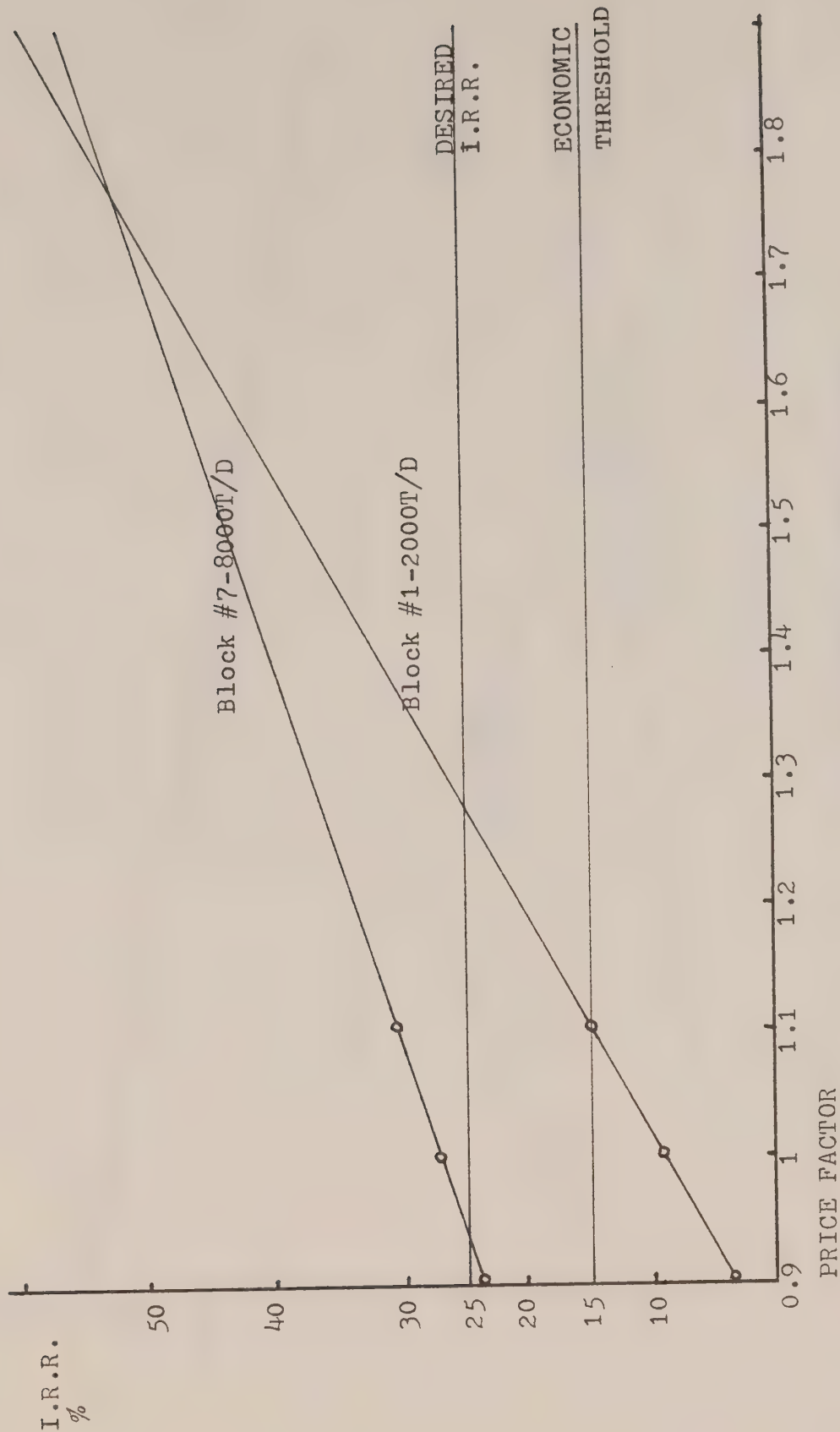


Fig. 21 1 REPRESENTS THE PRICE OF CHROMIUM AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES
COBALT PRODUCTION FOR BLOCKS 1 to 10

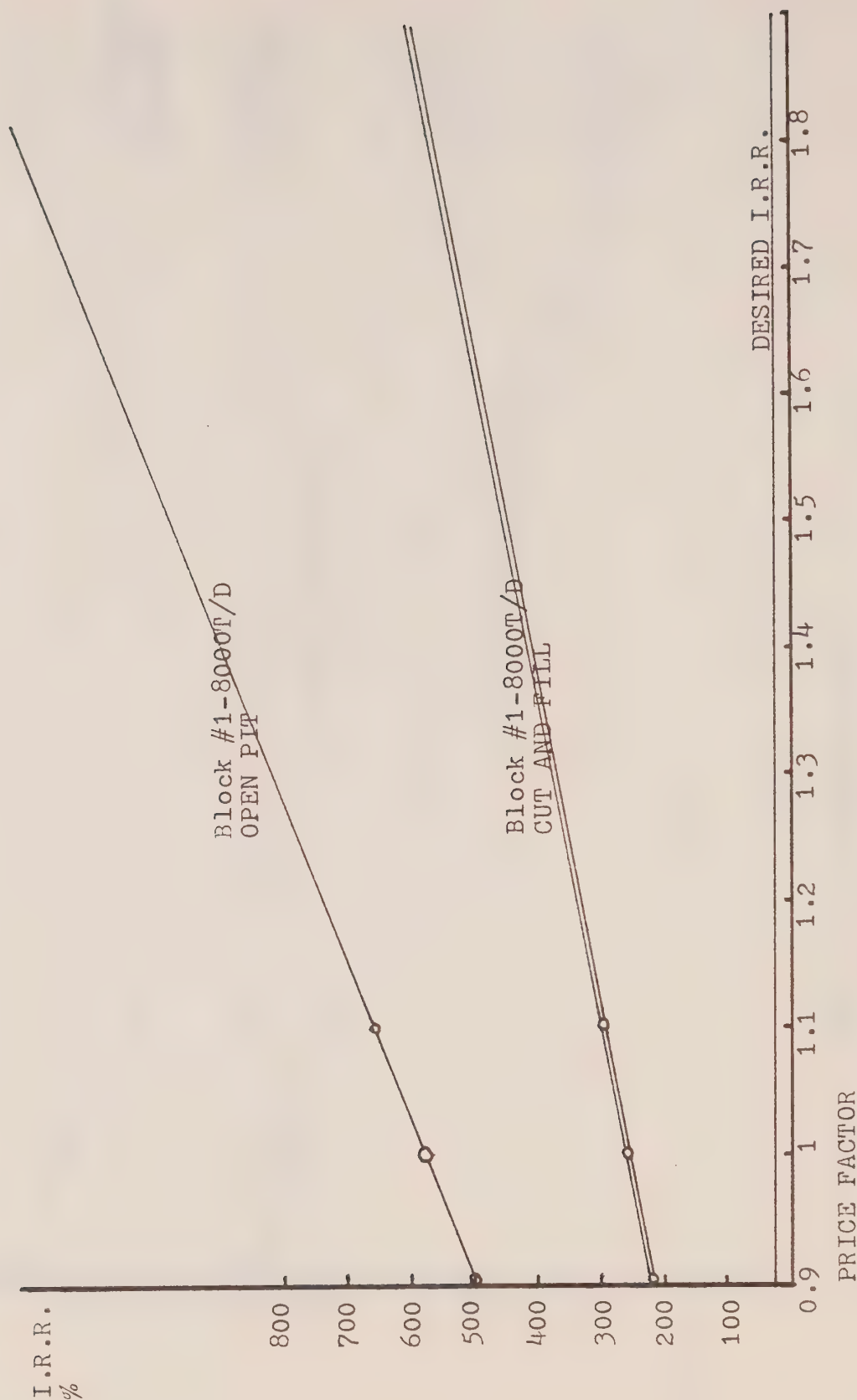
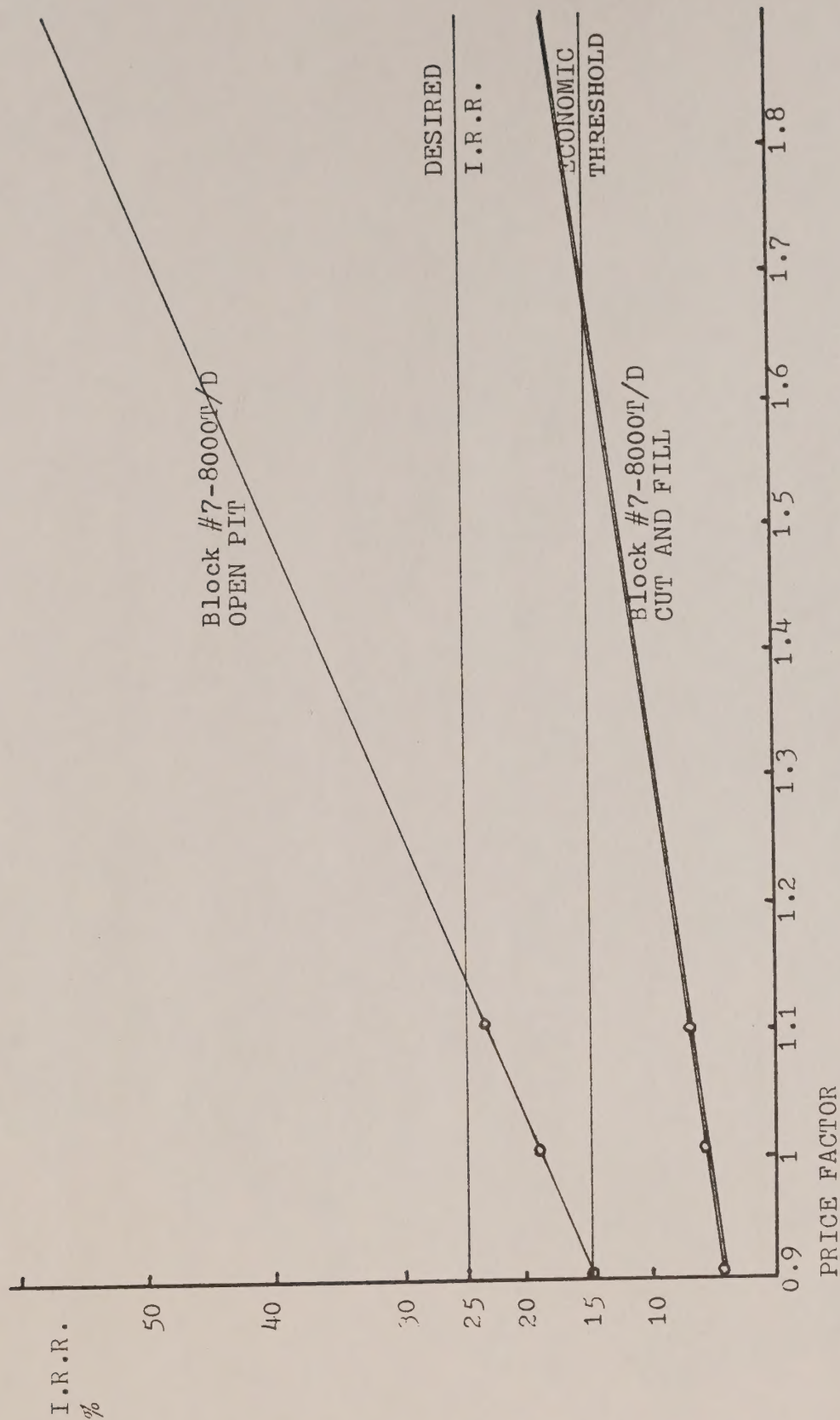


Fig. 22 1 REPRESENTS THE PRICE OF COBALT AT 1979 CONSTANT DOLLARS

SENSITIVITY OF I.R.R. TO PRICE CHANGES PLATINUM PRODUCTION FOR BLOCKS 1 to 10



1 REPRESENTS THE PRICE OF PLATINUM AT 1979 CONSTANT DOLLARS

Fig. 23

